Remarks

This Reply is timely filed and is responsive to the Office Action mailed January 26, 2006 (the "Office Action"). In the Office Action, claims 88-102 were pending and claims 88-102 were rejected.

In this Reply claims 88 and 95 have been amended and claims 96 and 101 have been cancelled. No new matter has been added. A schematic marked as Exhibit "A" is provided solely to facilitate comparison of the cited art system configurations as compared to Applicants' claimed system configuration.

Now turning to claim rejections based on cited art, Claims 88, 90-91, 94-99, and 100-102 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No 6,348,278 to La Pierre et al. ("La Pierre") in view of U.S. Patent No. 5,449,568 to Micheli et al. ("Micheli") Claim 89 is rejected under 35 U.S.C § 103(a) as being unpatentable over La Pierre in view of Micheli, as applied to claim 88, and further in view of U.S. Patent No. 6,375,716 to Burchell et al. ("Burchell"). Claims 92 and 93 are rejected under 35 U.S.C. § 103(a) as being unpatentable over La Pierre in view of Micheli, as applied to claim 88, and further in view of U.S. Patent No. 4,810,472 to Andrew et al. ("Andrew").

In Applicants Reply filed November 9, 2005 Applicants argued "A principal difference in the claimed invention over the cited art that provides a significant increase in efficiency is that in the claimed inventive system the mixed gas stream (fuel stream) first goes to an expansion turbine for generation of electricity before being electrochemically oxidized". Applicants then continued "The same mixed gas stream (fuel stream) is then directed to a gas separation device and the resulting respective separated gas streams are directed to separate fuel cells for electrochemical oxidation and production of additional electricity. Despite Applicants' arguments

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and detailed explanation regarding claimed inventive distinctions, the Examiner rejected all claims. According to the Examiner in the section entitled "Response to Arguments" (copied below):

Applicants' arguments filed 11/9/05 have been fully considered but they are not persuasive. (1) Applicants argued the "difference in the claimed Invention over the cited art that provides a significant increase in efficiency is that in the claimed Inventive system the mixed gas stream (fuel stream) first goes to an expansion turbine for generation of electricity before being electrochemically oxidized". It is submitted that the applied references are capable of performing the intended function of feeding the mixed gas to the turbine for generation of electricity before being electrochemically oxidized. Note, the system is being examined as an apparatus; thereby, the manner of operating the device does not differentiate apparatus claim from the prior art if the prior art apparatus teaches all the structural limitations of the claim. (See Exparte Masham, 2 USPQ2D 1647 (BD. Pat. App. & Inter. 1987). (2) Applicants argued the applied references fail to disclose or suggest using the turbines to produce electricity. Examiner respectfully disagrees. The turbines 45 and 47 of La Pierre are capable of generating electricity. Micheli also discloses the separated gas (via line 46) from a reformer (41) is feed to the turbine 26 to produce electricity (28). Micheli also discloses the separated

gas is fed to the turbines 64 and 68 to produce electricity as shown in Figure. (3) Applicants argued neither La Pierre nor Micheli disclose or suggest electrochemically oxidizing a second gas stream (retentate stream) to produce electricity. Examiner respectfully disagrees. LaPierre discloses the separated gas (purified hydrogen) is fed to the hydrogen fuel cell 52. Examiner agrees LaPierre fail to disclose a second fuel cell for electrochemically oxidizing said second gas stream (mainly CO2) to produce electricity. Micheli teaches the second gas stream (via line 46) containing mainly CO2 gas is fed to the CO2 fuel cell (14) to produce electricity (39). Thus, it would have been obvious in view of Micheli to one having ordinary skill in the art to modify the apparatus of LaPierre with a CO2 fuel cell as taught by Micheli in order to oxidize the second gas stream. (4) Applicant also argued the exhaust gas stream of Micheli is directed to the cathode of fuel cell 14 is electrochemically reduced, not electrochemically oxidized. Examiner respectfully disagrees. Micheli discloses the second gas stream of the claimed invention containing a high concentration of CO2 and the gas stream is fed to the solid oxide fuel cell 14 of the claimed invention to produce electricity. Thus, one of ordinary skill in the art in view of the applied references would have expected the exhaust gas stream being electrochemically oxidized in the fuel cell 14. In addition, "apparatus claims cover what a device is, not what a device does". See *In re Schreiber* and *Hewlett-Packard Co. v. Baush & Lomb Inc.* MPEP 2114.

In response, as amended, claim 88 (copied below; changes shown) now explicitly recites several additional structural limitations which clearly specify the unique interconnection of the various system components comprising Applicants' claimed system.

88. (Currently amended) A system for converting fuel energy to electricity, comprising:

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a reformer for converting a higher molecular weight gas into at least one mixed gas stream of lower average molecular weight comprising at least a first lower molecular weight gas and a second gas, said first and second gases being different gases, wherein said first lower molecular weight gas comprises H_2 and said second gas comprises CO;

at least one turbine coupled to an electrical generator having an input connected to an output of said reformer, said turbine [to produce] receiving said mixed gas stream and generating electricity from expansion of said mixed gas stream;

a separator connected to an output of said turbine, said separator having a first and a second output for dividing said mixed gas stream, wherein [into] a first gas stream mainly comprising said ~~first lower molecular weight gas~~ H_2 is provided at said first output and a second gas stream mainly comprising said ~~second gas~~ CO is provided at said second output;

a first fuel cell, an anode of said first fuel cell connected to said first output for electrochemically oxidizing said first gas stream to produce electricity; and

a second fuel cell, an anode of said second fuel cell connected to said second output for electrochemically oxidizing said second gas stream to produce electricity.

The structural features added to amended claim 88 are clearly shown in Exhibit "A" and include:

(i) a "turbine coupled to an electrical generator having an input connected to an output of said reformer, said turbine receiving said mixed gas stream (output by the reformer) and generating electricity from expansion of said mixed gas stream";

(ii) a "separator connected to an output of said turbine, said separator having a first and a second output for dividing said mixed gas stream",

(iii) the "anode of said first fuel cell connected to said first output (of said separator) for electrochemically oxidizing said first gas stream to produce electricity" and

iv) the "anode of said second fuel cell connected to said second output (of said separator) for electrochemically oxidizing said second gas stream to produce electricity".

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Amended claim 88 thus recites a system for converting fuel energy to electricity, comprising a reformer for converting a higher molecular weight gas into at least one mixed gas stream (fuel stream) of lower average molecular weight comprising at least a first lower molecular weight gas and a second gas, the first and second gases being different gases. The output of the reformer is connected to the claimed turbine which coupled to an electrical generator to produce electricity from expansion of the mixed gas stream (fuel stream provided by the reformer). Support for the turbine coupled to an electrical generator can be found in the paragraph beginning on line 19 page 11 of Applicants' specification. A separator is connected to the output of the turbine. The separator divides the mixed gas stream into a first gas stream mainly comprising the H_2 and a second gas stream mainly comprising the CO. The claimed system also recites two (2) fuel cells each of which produces electricity by electrochemically oxidizing at their anodes a fuel from the respective gas streams generated by the reformer and split by the separator.

A principal difference in the claimed invention over the cited art that provides a significant increase in efficiency is that in the claimed system the mixed gas stream (fuel stream) output by the reformer *first* goes to an expansion turbine (which is coupled to an electric generator) for generation of electricity before being electrochemically oxidized by fuel cells. As noted on pages 12 lines 2 -7 Applicants' application:

> The thermodynamic efficiency of the turbine expansion process is increased compared to prior systems in at least two ways. The use of a working fluid or working fluid mixture having a high specific volume (such as CO and H_2) to power turbine 120 results in an increased power density and energy conversion efficiency for the overall power system compared to systems which use lower specific volume working fluids, such as conventional combustion products (e.g. CO_2 and air).

As noted on page 12, line 18 to page 13, line 1:

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Thus, assuming the same rate of expansion in turbine 120, the specific power (power/mass) generated by the expansion of the synthesis gas is approximately two and three times greater, respectively, compared to turbines which use steam or air as the working fluid.

The second "way" the claimed arrangement where the turbine produces electricity from expansion of the mixed gas stream increases efficiency is described on page 13, lines 3-8 (copied below):

In addition, the use synthesis gas as the working fluid for turbine expansion largely avoids the inherent thermodynamic efficiency limitations imposed by the Carnot principle on conventional power systems which use cyclic processes because the synthesis gas used by system 100 goes to the turbine 120 at an elevated pressure (e.g. the pressure of a typical gas main) and is subsequently reacted electrochemically.

The same mixed gas stream (fuel stream) is then directed to a gas separation device (separator) and the resulting respective separated gas streams, are directed to separate fuel cells for electrochemical oxidation and production of additional electricity. In contrast, as will be demonstrated below, La Pierre and Micheli both exclusively teach first directing the fuel gases to a fuel cell for generation of electricity. The fuel gases thus undergo electrochemical reactions and are as a result changed in composition.

La Pierre is entitled "method and system for supplying hydrogen for use in fuel cells" and discloses a method and system for efficiently producing hydrogen that can be supplied to a fuel cell. The method and system produce hydrogen in a reforming reactor (12) using a hydrocarbon stream and water vapor stream as reactants. The hydrogen produced in the reformate stream is purified in a hydrogen separating membrane (14) to form a retentate stream stripped of H_2 (42) and a purified hydrogen stream (40). The purified hydrogen stream (40) is then fed to a fuel cell (52) where electrical energy is produced and a fuel cell exhaust stream containing water vapor and oxygen depleted air is emitted. In a preferred embodiment, a means and method is provided for recycling a portion of the retentate stream (42) to the reforming reactor (12) for increased hydrogen yields. In another embodiment, a combustor (94) is provided for combusting a second

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portion of the retentate stream to provide heat to the reforming reaction or other reactants. In the preferred embodiment, the combustion is carried out in the presence of at least a portion of the oxygen depleted air stream from the fuel cell (52).

A key aspect of LaPierre's invention is efficient use of the heat and energy from various product streams to increase the efficiency of H_2 production According to the Background, col. 2 line 66 to col. 3, line 3 "Thus, there is a need in the art for a method and system, based on the reforming of hydrocarbons, for efficiently supplying hydrogen to a fuel cell. Particularly, there is a need to more efficiently use the products, heat, or energy generated in the reforming reaction and fuel cell to operate the system. There is also a need to optimize the yields of hydrogen obtained from the reforming reaction while maintaining energy efficiency of the system". According to LaPierre's Summary of the invention, col. 3, lines 14-17 "The method and system of the present invention uses the products and the associated energy and/or heat produced from the system to operate the system". Col. 9, lines 19 to col. 10, line 25 is copied below regarding specificity regarding this key aspect:

The fuel cell integrated system 10 efficiently uses the heat and energy from various product streams to efficiently produce hydrogen. For example, in a preferred embodiment, as shown in FIG. 1, the fuel cell integrated system 10 has a retentate recycle means that includes a splitter 44, for removing at least a portion of the retentate stream 42 as a retentate recycle stream 46 and recycling it to the reforming reactor 12 Another portion of the retentate stream 42 is shown as an exhaust tail gas stream 48 that is preferably oxidized in a combustor 94 (described hereinafter). *It will be apparent to those skilled in the art that any suitable means for recycling the retentate stream may be used that removes a portion of the retentate stream for recycle and directs the retentate recycle to the reforming reactor.* It is also desirable that the retentate recycle means be capable of operating at the temperatures and pressures of the reforming reactor. Suitable retentate recycle means include for example, a splitter used in conjunction with, but not limited to, a turbine or other type of compression pump

By recycling a portion of the retentate stream to the reforming reactor higher yields of hydrogen per mole of hydrocarbon reacted can be achieved. For example, thermodynamic calculations suggest that recycling a portion of the retentate stream 42 shifts the equilibrium of Equations (I, II, and III) to produce more hydrogen. This results because the retentate stream 42 contains primarily water vapor and is partially depleted of hydrogen, thereby reducing the concentration

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of hydrogen and increasing the concentration of water vapor in the reforming reaction zone. This shift in hydrogen and water vapor concentrations in the reforming reaction zone drives the reaction equilibriums to produce more hydrogen, and less methane and carbon monoxide. Although the retentate stream 42 also contains carbon dioxide, the level of carbon dioxide does not outweigh the effect of the additional water vapor to drive the production of hydrogen.

In addition to shifting the equilibrium reaction towards the production of more hydrogen, the higher flow rates through the reactor with recycle lead to improved mixing which results in a more uniform temperature distribution and better contacting of the reactants with the catalyst. Recycle also desirably introduces hydrogen at the inlet of the reforming reactor thereby reducing coking (deposition of carbon) on the catalyst. An additional advantage to recycling the retentate stream 42 is that the external requirements for water are reduced, allowing the reforming reactor to be efficiently operated at lower steam to feed carbon ratios.

Preferably the retentate recycle ratio, expressed as the moles of retentate recycle stream 46 to the moles of exhaust tail gas stream 48 is preferably from about 1:20 to about 20:1, more preferably from about 1:1 to about 10:1, and most preferably from about 2:1 to about 5:1. By recycling a portion of the retentate stream 42, the yields of hydrogen, on a molar basis, can be increased by at least 10% more preferably 50% and most preferably 100% based on the yield of hydrogen obtained with no recycle of the retentate stream 42. Although it would be expected that a higher retentate recycle ratio would produce the highest yield of hydrogen and would therefore be most desirable, it has been discovered that for an overall energy efficient system, it is most desirable to not recycle all of the retentate stream to the reforming reactor. Rather, it is desirable to direct at least a portion of the retentate stream to combustor 94 to supply heat to the reforming reactor, the hydrocarbon feed, the water stream, or retentate recycle stream, or combinations thereof. Additionally, in the case where the reforming reactor is operated at a higher temperature than the hydrogen separating membrane, which could be limited by the physical characteristics of the membrane, increasing the retentate recycle stream, increases the amount of heat needed to bring the retentate recycle stream up to operating temperatures of the reforming reactor. Thus, the preferred amount of retentate stream recycled above needs to take into account a variety of factors

Thus, LaPierre teaches that the retentate (42) from the hydrogen separation device (14) is divided into two streams of identical composition, one of which is sent to a recycle turbine (45) or other pressure increasing device, i.e., a compressor for compression up to the pressure of the reformer and this stream, which has considerable CO, is further reformed to produce more hydrogen. See Exhibit "A". LaPierre teaches that the second divided portion of the retentate stream, referred to as the exhaust tail gas stream is delivered to an exhaust turbine (47) or other

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pressure reducing device to decrease the pressure of the exhaust tail gas stream to the operating pressure of the combustor.

Although the Examiner asserts in the "Response to Arguments," that "The turbines 45 and 47 of LaPierre are capable of generating electricity", Applicants respectfully disagree. Neither turbine 45 or 47 is a power turbine. According to LaPierre turbine 45 is "... a recycle turbine **45** or other pressure increasing device.. " [Column 14; Lines 31-32] It is often called a turbocompressor. This is an energy consuming device and is not capable of producing electricity, only consuming it. According to LaPierre turbine 47 is "...an exhaust turbine **47** or other similar pressure reducing device...." [Column 14; Lines 35-36] Its stated function is to decrease the pressure of the exhaust tail gas stream **48** to the operating pressure of the combustor.

Applicants also note that LaPierre's turbines 45 and 47 are also positioned differently in his disclosed system and act on a different gas stream as compared to Applicants' claimed turbine which has its input connected to an output of the reformer (thus receiving the mixed fuel gas stream). See Exhibit "A"

The exhaust tail gas stream follows a circuitous route to the combustor internally disposed in reformer 12 where it is combined with fuel gas and other recycle gases and combusted to provide the heat for the reformer 12. Thus, the net result of the teaching of LaPierre is that the second portion of the divided retentate stream, called the exhaust tail gas stream (47), is directed to the internal combustor and burned to provide heat for the reforming reaction which increases efficiency of H_2 production. Thus, the rententate stream (42) having considerable CO is divided between a recycle turbine (45) or other pressure increasing device

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and exhaust turbine (47) or other pressure reducing device to decrease the pressure of the exhaust tail gas stream to the operating pressure of the combustor (110).

As correctly noted by the Examiner, LaPierre discloses a single fuel cell. The H_2 rich fuel stream provided by La Pierre's separator 14 is the fuel which is fed to the anode of fuel cell 52 where it is electrochemically oxidized.

LaPierre does not recognize that the CO comprising retentate flow can be used as a fuel source to be electrochemically oxidized by a fuel cell. Moreover, the disclosed composition of retentate stream 42 by La Pierre comprises water vapor, carbon dioxide, methane and carbon monoxide (Column 8; Lines 48-50) teaches away from use of retentate stream 42 as a fuel since only methane and carbon monoxide are directly electrochemically oxidizable. Carbon dioxide is not a fuel as it cannot be oxidized being in its fully oxidized state. La Pierre instead as noted above throughout teaches using the CO comprising retentate flow to increase the efficiency of hydrogen production.

LaPierre explicitly teaches away from using CO in a fuel cell. Specifically, LaPierre teaches that carbon monoxide (CO) is an *impurity* for a fuel cell. Col. 8, lines 39-46 disclose the following

The hydrogen leaves the permeate side 38 of the membrane as a purified hydrogen stream 40 that contains preferably less than 10,000 ppm impurities, more preferably less than 50 ppm impurities and most preferably less than 10 ppm impurities (based on total volume of the purified hydrogen stream). By *"impurities" it is meant substances that adversely affect the performance of the fuel cell such as carbon monoxide*. The portion of the reformate stream 32 remaining on the retentate side 36 leaves the hydrogen separating membrane 14 as a retentate stream 42 that contains water vapor, carbon dioxide, methane, carbon monoxide, and possibly unreacted or partially reacted hydrocarbons.

Thus, La Pierre does not disclose or suggest Applicants' claimed turbine (which is coupled to an electric generator) connected to an output of the reformer for producing electricity from expansion of the mixed (H_2 and CO comprising) gas output. Moreover, as correctly noted

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by the Examiner, La Pierre does not disclose or suggest a second fuel cell to electrochemically oxidize a second gas stream (the retentate stream) to produce electricity. As noted above, La Pierre fact teaches away from use of a second fuel cell based on (i) utilizing the retentate flow to increase H_2 production efficiency of the reforming reaction and (ii) the characterization of CO as an impurity being in a class of *"substances that adversely affect the performance of the fuel cell"*

Micheli is used by the Examiner in an attempt to make up for La Pierre's acknowledged single fuel cell deficiency. According to the Examiner regarding Micheli:

> electricity. Micheli teaches the second gas stream (via line 46) containing mainly CO2 gas is fed to the CO2 fuel cell (14) to produce electricity (39). Thus, it would have been obvious in view of Micheli to one having ordinary skill in the art to modify the apparatus of LaPierre with a CO2 fuel cell as taught by Micheli in order to oxidize the second gas stream. (4) Applicant also argued the exhaust gas stream of Micheli is directed to the cathode of fuel cell 14 is electrochemically reduced, not electrochemically oxidized. Examiner respectfully disagrees. Micheli discloses the second gas stream of the claimed invention containing a high concentration of CO2 and the gas stream is fed to the solid oxide fuel cell 14 of the claimed inventon to produce electricity. Thus, one of ordinary skill in the art in view of the applied references would have expected the exhaust gas stream being electrochemically oxidized in the fuel cell 14. In addition,

Applicants respectfully disagree with many of the assertions above regarding Micheli noted above and in the "Response to Arguments" section . Micheli discloses an indirect-heated gas turbine cycle is bottomed with a fuel cell cycle with the *heated air discharged from the gas turbine being directly utilized at the cathode of the fuel cell for the electricity-producing electrochemical reaction occurring within the fuel cell.* The fuel cell disclosed is a molten carbonate fuel cell (MCFC). The following is taken from the DOE Office of Fossil Energy Web

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Site regarding MCFCs (see url http://www.fossil.energy.gov/programs/powersystems/fuelcells/fuelcells_moltencarb.html): "At the anode, hydrogen reacts with the carbonate ions to produce water, carbon dioxide, and electrons The electrons travel through an external circuit creating electricity and return to the cathode. There, oxygen from the air and carbon dioxide recycled from the anode react with the electrons to form carbonate ions that replenish the electrolyte and provide ionic conduction through the electrolyte, completing the circuit."

Thus, the electrochemical reactions occurring in the MCFC cell are:

oxidation of hydrogen at the anode: $H_2 + CO_3{=} = H_2O + CO_2 + 2e$-

reduction of oxygen at the cathode: $1/2O_2 + CO_2 + 2e- = CO_3$

with the overall cell reaction: $H_2 + 1/2O_2 + CO_2$ (cathode) = $H_2O + CO_2$ (anode)

The hot cathode recycle gases provide a substantial portion of the heat required for the indirect heating of the compressed air used in the gas turbine cycle. A separate combustor provides the balance of the heat needed for the indirect heating of the compressed air used in the gas turbine cycle. Hot gases from the fuel cell are used in the combustor to reduce both the fuel requirements of the combustor and the NO_x emissions therefrom. Residual heat remaining in the air-heating gases after completing the heating thereof is used in a steam turbine cycle or in an absorption refrigeration cycle.

Referring to Exhibit "A", Micheli thus discloses a system having a single fuel cell as does La Pierre. Micheli's fuel cell 14 receives fuel that has not been reformed, such as natural gas 37 at anode 36 where it is electrochemically oxidized. Micheli discloses use of hot CO_2 to the cathode of the MCFC fuel cell 14 as noted below, where the CO_2 is derived from gas exhausted

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from the anode 36 of fuel cell 14. CO_2 is thus not a fuel in Micheli, rather it is used together with oxygen for the reduction reaction and replenishment of the molten carbonate electrolyte.

For this purpose gases exhausted from the anode 36 are passed through a conduit 42 into the catalytic reactor 41 where they are mixed with a portion of the recycle gases from the cathode 32 that are conveyed to the reactor 41 through conduit 43. The hot gases resulting from the catalytic reaction including the CO_2 are discharged from the reactor 41 and conveyed into a CO_2 separator 44 through conduit 45 for the separation of the CO_2 from the stream of reaction gases. This separation of the CO_2 from the stream of reaction gases can be achieved in any suitable manner such as by using a ceramic membrane selectively permeable to CO_2. The stream of CO_2 separated from the reactor exhaust stream can be mixed with the cathode air stream by connecting the CO_2 separator to the conduit 34 with conduit 46. If additional CO_2 is required for the electrochemical reaction during fuel cell start-up or during the operation of the fuel cell, selected amounts of CO_2 from any suitable source (not shown) can be added to the cathode air supply via line 47 shown coupled to line 46.

In the Examiner's "Response to Arguments," the Examiner asserts "it would have been obvious in view of Micheli to one having ordinary skill in the art "...to modify the apparatus of LaPierre with a CO_2 fuel cell as taught by Micheli in order to oxidize the second gas stream." Applicants respectfully disagree. LaPierre's retentate gas stream is the stream in question here and in LaPierre, this stream is divided into two streams of identical composition, i.e., the "...retentate recycle stream 46 and exhaust tail gas stream 48." Although these streams have significant fuel value, i.e., oxidizable species, and are used in the reforming reactor and combustor, respectively, to provide reactants for more hydrogen production or for heat, they are not suitable fuels for electrochemical oxidation at the anode of a fuel cell due to diluents, contaminants, and reaction products of reforming. The retentate stream is also not suitable as an oxidizing agent on the cathode side of a fuel cell. The "CO_2 fuel cell" of Micheli is a molten carbonate fuel cell and the CO_2 is used to replenish the molten carbonate through reaction with oxygen in the air stream at the cathode of the fuel cell. Absolutely, unequivocally, electrochemical oxidation in a fuel cell occurs only at the anode and, conversely, electrochemical reduction in a fuel cell occurs only at the cathode. The retentate gas stream of LaPierre thus

would clearly not be a suitable feed for the cathode as it contains fuel gases, which are oxidizable and reduction occurs at the cathode.

In the Examiner's Response to Arguments," the Examiner also asserts "Micheli also discloses the separated gas (via line 46) from a reformer (41) is feed to the turbine 26 to produce electricity (28)." Applicants respectfully disagree with this assertion. As stated in Micheli [Column 6; Lines 22-28] 41 is ".. a residual fuel converter such as a catalytic reactor shown at 41 can be used to produce CO_2 by reacting gaseous reactants in the anode and cathode gas streams including residual fuel values in the anode exhaust stream in the presence of a suitable catalyst such as a platinum-nickel catalyst." Thus, 41 is not a reformer as asserted but rather an oxidizer to convert all residual fuels and byproducts as a heat source. Further, CO_2 is not fed to turbine 26; rather the CO_2 is mixed with the cathode air stream [Column 6; Lines 39-42] and delivered to the cathode if fuel cell 14-See Exhibit "A" also. Turbine 26 is an indirect-fired gas turbine that uses air as the working fluid [Column 5; Lines 33-36]. The cathode air stream is the hot air stream exhausted from the gas turbine 26 [Column 5; Lines 33-36].

Moreover, in the Examiner's "Response to Arguments," the Examiner asserts that "...the separated gas is fed to the turbines 64 and 68 to produce electricity...." Applicants respectfully disagree with this assertion. Micheli actually discloses [Column 7; Lines 53-58] that "...these exhaust gases are preferably passed through line 60 into a boiler or the like 62 of a steam turbine cycle 64 for the generation of electrical power by a generator 66." Further, Micheli discloses [Column 8; Lines 8-12] "...a low-pressure turbine 68 with an electrical generator 70 is connected...to the cathode discharge line 48 for receiving a portion or all of the cathode exhaust stream"

The Examiner uses as the motivation to combine Micheli with La Pierre "to produce electricity" to assert that it would have been "obvious in view of Micheli '568 to one having ordinary skill in the art to modify the fuel converting system of La Pierre with a second fuel cell … as taught by Micheli to produce electricity" Applicants respectfully disagree with the asserted combination as explained below because the cited art does not contain any suggestion or incentive that would have motivated one skilled in the art to modify a reference or to combine the respective references to obtain the claimed invention.

As noted above, Micheli's MCFC fuel cell requires a supply of fuel 37 to produce electricity. The CO_2 generated by Micheli's system used by the fuel cell 14 is not a fuel and is supplied to the cathode of the MCFC for combination with oxide ions produced in the reduction reaction to form carbonate. Accordingly, although electricity is produced by fuel cell 14, fuel must be supplied to the anode of the fuel cell to produce the electricity. Thus, the proposed insertion of Micheli's fuel cell into La Pierre's system would require a fuel flow to the anode and the retentate flow 42 to the cathode. The requirement for a fuel flow (reference 37 in Micheli) for operation of the Micheli fuel cell 14 would by itself teach away from its addition to La Pierre's system.

Micheli teaches the use of a fuel cell operating on a gas mixture that has not been reformed and thus teaches the use of only one fuel cell that is capable of internal reforming, which eliminates the possibility of separating the mixed gases into component parts that may be used separately as fuel for fuel cells.

Both Micheli and LaPierre teach away from the use of a CO-rich stream as a fuel for a fuel cell, such as Applicants' claimed second fuel cell. As noted above, LaPierre at Column 8, Lines 44-46, characterizes CO as an "impurities" since it is in a class of materials "that adversely

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affect the performance of the fuel cell such as carbon monoxide." Micheli teaches the use of a fuel gas, such as natural gas, that has not undergone a separation step into its constituent parts, as fuel for the fuel cell. Thus, Micheli teaches the use of natural gas, synthesis gas, or other gas mixture but teaches away for a separation process to enrich a stream in either hydrogen or CO

Finally, as noted above, La Pierre in fact teaches away from use of a second fuel cell based on the focus of his invention being utilizing the retentate flow to increase H_2 production efficiency of the reforming reaction.

Accordingly, as explained above, a prima facie case for obviousness is not present because the cited art does not contain any suggestion or incentive that would have motivated one skilled in the art to modify the references or to combine references to obtain the claimed invention. Moreover, Applicants have submitted persuasive objective evidence that demonstrates it is not even reasonable to combine La Pierre and Micheli.

The proposed combination of La Pierre and Micheli does not disclose or suggest Applicants' claimed "turbine coupled to an electrical generator having an input connected to an output of said reformer, said reformer receiving said mixed gas stream and generating electricity from expansion of said mixed gas stream [generated by the reformer]". This novel arrangement allows the mixed gas stream (fuel stream) to first go to an expansion turbine for generation of electricity before being electrochemically oxidized and provides a significant increase in efficiency as described in Applicants' application due in part to the use of a working fluid or working fluid mixture having a high specific volume (such as CO and H_2) to power turbine 120 resulting in an increased power density and energy conversion efficiency for the overall power system compared to systems which use lower specific volume working fluids, such as conventional combustion products (e.g. CO_2 and air).

Although both La Pierre and Micheli disclose turbines, the turbines are not connected to the output of a reformer as claimed by Applicants. In La Pierre, although a reformer 12 and turbines 45,47 are disclosed, a separator 14 is disposed between reformer 12 and turbines 45, 47.

Thus, Micheli does not make up for La Pierre's deficiency of failing to disclose or suggest Applicants' claimed (i) "turbine coupled to an electrical generator having an input connected to an output of said reformer, said turbine receiving said mixed gas stream and generating electricity from expansion of said mixed gas stream" and ii) "a second fuel cell connected to said second output [wherein a "gas stream mainly comprising said CO is provided at said second output"] for electrochemically oxidizing said second gas stream to produce electricity". Accordingly, amended claim 88 and its respective dependent claims evidence an inventive step and are thus patentable over the cited art.

Applicants have made every effort to present claims which distinguish over the cited art, and it is believed that all claims are now in condition for allowance. However, the Examiner is invited to call the undersigned (at 561-671-3662) if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance.

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Although no fees are believed to be due, the Commissioner for Patents is hereby authorized to charge any deficiency in fees due with the filing of this document and during prosecution of this application to Deposit Account No. 50-0951.

Respectfully submitted,

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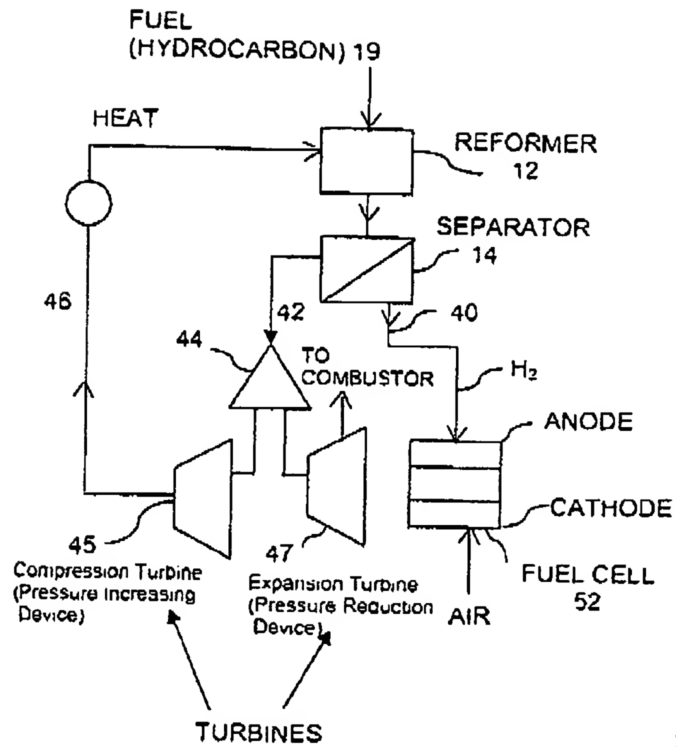
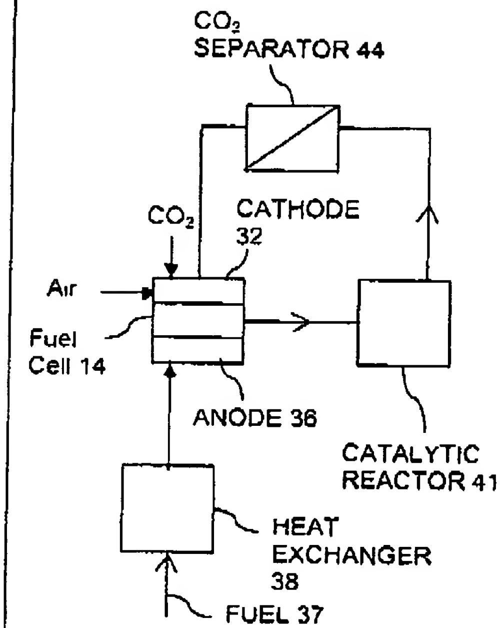
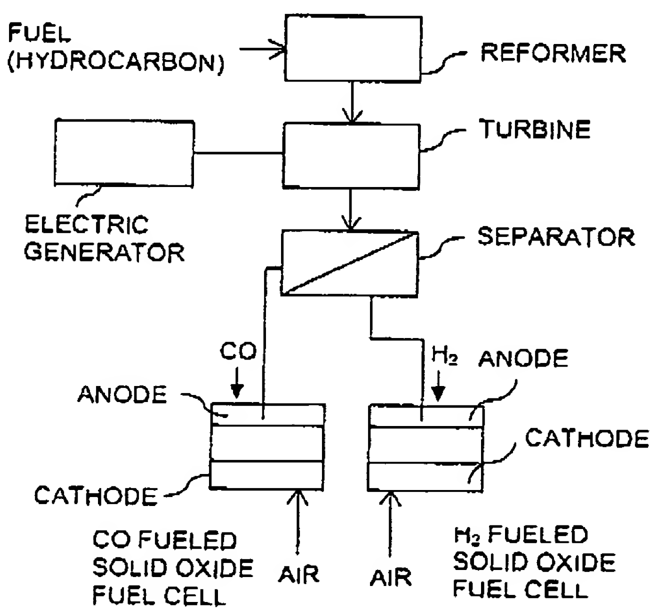
EXHIBIT "A"



LA PIERRE



MICHELI



CLAIMED INVENTION